KEITHLEY

GPIB 488.1 Protocol
For the Models 24xx and Model 6430

Packing List

Overview

The SourceMeter now supports two GPIB protocols: SCPI and 488.1. The 488.1 protocol was added to significantly increase speed over the GPIB.

When using the 488.1 protocol, throughput is enhanced up to 10x for data sent to the SourceMeter (command messages) and 20x for data returned by the SourceMeter (response messages).

The speed that readings are sent over the GPIB is also increased as shown in the attached charts. Chart 1 shows bus reading rates for sweep operation, and Chart 2 shows reading rates for single shot operation. Included in both charts is the percentage improvement achieved by using the 488.1 protocol instead of the SCPI protocol.

The significant speed improvements are shown in the shaded areas of the charts. For sweep operation (Chart 1), the reading rate can be increased by almost 50%, and for single shot operation (Chart 2), the reading rate can be increased by >100%.

NOTE *With the 488.1 protocol selected, you will still use SCPI commands to program the SourceMeter. Operation differences between the two protocols are discussed later in this packing list.*

Selecting the 488.1 protocol

Perform the following steps to select the 488.1 protocol:

1. Press MENU to display the MAIN MENU.
2. Place the cursor on COMMUNICATION and press ENTER to display the COMMUNICATIONS SETUP menu.
3. Place the cursor on GPIB and press ENTER to display the present GPIB address.
4. Press ENTER to display the GPIB PROTOCOL menu.
5. Place the cursor on 488.1 and press ENTER.
6. Use the EXIT key to back out of the menu structure.

When switching between the SCPI protocol and 488.1 protocol, the instrument does not reset. The selected GPIB protocol is saved in EEPROM and will power up with that selected protocol.

The GPIB protocol cannot be changed over the bus. However, there is a query command to determine the presently selected protocol. When the 488.1 protocol is selected, the message exchange protocol (MEP) disables. Therefore, if you query the state of MEP, you will know which protocol is enabled:

:SYSTem:MEP[:STATe]?

If a "1" is returned, MEP is enabled therefore the SCPI protocol is selected. A "0" indicates that MEP is disabled, therefore the 488.1 protocol is disabled. To summarize:

1 = SCPI protocol
0 = 488.1 protocol

Protocol differences

The following information covers the differences between the 488.1 protocol and the SCPI protocol.

Message exchange protocol (MEP)

When the 488.1 protocol is selected, the MEP is disabled to speed up GPIB operation.

The following guidelines/limitations must be followed when using the 488.1 protocol:

- If a query is sent, it must be the only command on the line (this also means no multiple queries). Otherwise, full SCPI command syntax is still supported including long-form and short-form commands, multiple commands, and MIN/MAX/DEF.

  For example, the following command strings are invalid:
  :VOLT:RANG 10;*OPC?
  :RES:RANG?;:READ?
  :READ?;:READ?

  The following command strings are valid:

  :SOUR1:VOLTage:STARt 1;STOP 10;step 1
  :volt:nplc 1.0;:curr:rang min
  :RES:RANG? MAX
  :READ?

- When a query is sent, either the data must be read back or a Device or Interface Clear must be performed to reset the query.
- When sending a command or query, do not attempt to read data from the SourceMeter until the terminator has been sent (usually Line Feed with EOI). Otherwise, a Device or Interface Clear must be sent to reset the input parser.
- When receiving data, all data, up to and including the terminator (LF with EOI), must be accepted. Otherwise, a Device or Interface Clear must be sent to reset the output task.
- Empty command strings (terminator only) should not be sent.

SCPI based programs – In general, an existing SCPI based program will run properly and faster in the 488.1 protocol if it meets the above guidelines and limitations.

Bus hold-off

*OPC, *OPC?, and *WAI are still function, but are not needed for the 488.1 protocol. When sending commands, the GPIB is automatically held-off when it sees a terminator come in. The hold-off is released when all off the commands have finished executing, or there is some parser or command error. An exception is an initiate command which releases the hold-off immediately and does not wait for all of the readings to be acquired. This immediate release of bus hold-off is done to support GET, SDC, IFC, *TRG, *RCL, *RST, SYSTem:PRESet and ABORt during data acquisition.

Trigger-on-talk

Trigger-on-talk functionality has been added for the 488.1 protocol. If a query has not been received by the instrument, then addressing he SourceMeter to talk will automatically send a READ? command. This technique increases GPIB speed by decreasing the transmission and parser times for the command.

Trigger-on-talk is extremely useful in the single-shot reading mode (*RST default) and is why there can be a >2x speed improvement over the SCPI protocol. Remember that the output must be on (:OUTput:STATe ON) before you can take readings.

The ARM:SOUR BUS and ARM:COUN INF commands are not supported by READ? with the 488.1 protocol selected. If you send one of these commands, a device or interface clear may need to be sent to reset the GPIB.

Message available

The MAV (message available) bit in the Serial Poll byte will be set when the query is finished being processed, not when there is data available in the output buffer (like SCPI). For the 488.1 protocol, output data will not be formatted until the first request for data is received. This may cause unexpected timeouts when using SRQ on MAV for queries that take a long time to execute.

General operation notes

- The TALK, LSTN, and SRQ annunciators are not functional in the 488.1 protocol.. This speeds up data throughput greatly. The REM annunciator still operates since it is critical to fundamental GPIB operation.
- If the unit is in REMote, the GTL command may not put the SourceMeter into the local mode. Only the front panel LOCAL key is guaranteed to operate, if not in local lockout (LLO). GTL will still disable LLO.
- IEEE-488 bus commands and features (GET, IFC, SDC, DCL, LLO, Serial Poll, and SRQ) are still fully supported.
- Multiple TALKs on the same query are supported as in the SCPI protocol. This is useful when reading back long ASCII strings.

GPIB Reading Speed Comparisons Between SCPI and 488.1

Chart 1 - Sweep Operation (rdgs/sec)

Speed	NPLC/Trig Origin	Measure		%	Source-Measure		%	Src-Meas-Limit Test[1]		%	Source-Memory[1]		%
		SCPI	488.1	Improvement	SCPI	488.1	Improvement	SCPI	488.1	Improvement	SCPI	488.1	Improvement
Fast	0.01/internal	1198.7	1759.6	46.78%	999.9	1369.3	36.94%	809.5	981.1	21.19%	164.8	165.2	0.23%
	0.01/external	1079.3	1254.7	16.25%	916.0	1035.2	13.02%	756.2	886.9	17.28%	162.6	163.0	0.23%
Medium	0.10/internal	509.6	511.5	0.37%	470.2	471.6	0.29%	388.9	398.0	2.35%	132.8	133.0	0.15%
	0.10/external	438.4	440.2	0.41%	409.3	409.8	0.12%	374.6	383.9	2.47%	131.4	131.4	0.00%
Normal	1.00/internal	59.0	59.0	0.00%	58.4	58.4	0.00%	56.9	57.1	0.41%	44.4	44.4	0.00%
	1.00/external	57.9	57.9	0.00%	57.3	57.3	0.00%	56.6	56.9	0.48%	44.2	44.2	0.00%

Chart 2 - Single Shot Operation (rdgs/sec)

Speed	NPLC/Trig Origin	Measure		%	Source-Measure[2]		%	Src-Meas-Limit[1, 2]		%
		SCPI	488.1	Improvement	SCPI	488.1	Improvement	SCPI	488.1	Improvement
Fast	0.01/internal	256.0	537.8	110.08%	79.5	140.0	76.15%	79.3	135.9	71.44%
Medium	0.10/internal	167.3	294.3	75.88%	72.9	116.9	60.27%	69.9	113.9	62.81%
Normal	1.00/internal	49.2	53.9	9.47%	34.9	42.3	21.20%	35.0	41.7	19.33%

1 Pass/Fail test performed using one high limit and one low math limit.
2 Includes time to re-program source to a new level before making measurement.